(NASA-TM-80015) OAST THEME WORKSHOP. VOLUME 3: WORKING GROUP SUMMARY. 8: STRUCTURES, DYNAMICS (M-2). A. STATEMENT. B. TECHNOLOGY NEEDS (FORM 1). C. PRIORITY ASSESSMENTS (FORM 2) (NASA) 39 p HC A03/MF G3/12

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OAST SPACE THEME WORKSHOP

VOLUME III

WORKING GROUP SUMMARY

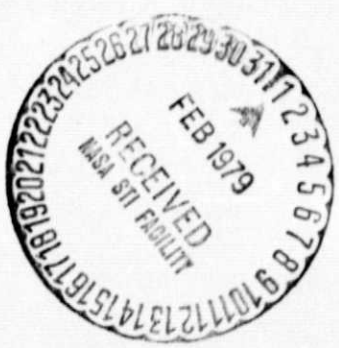
VIII. STRUCTURES, DYNAMICS (M-2)

A. STATEMENT

B. TECHNOLOGY NEEDS (FORM I)

C. PRIORITY ASSESSMENTS (FORM II)

HELD AT THE
LANGLEY RESEARCH CENTER
APRIL 26-30, 1976



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Foreword

The attached material represents the working papers from the OAST Space Theme Workshop held at the Langley Research Center, April 26-30, 1976, and contains a quick-look analysis of the proceedings. The material is unedited and intended for further use by the participants of the workshop and the planning elements of NASA concerned with space mission research and technology. It should be understood that the data do not represent official plans or positions but are part of the process of evolving such plans and positions.

Nearly 100 of the Agency's top technologists and scientists joined with another 35 theme specialists to produce this working document - a document that provides a technical foundation, including research and technology base candidates, for each of the six space themes.

The material in this report is considered essential to the development of Center initiatives in support of these themes. Copies of the report will be made available to the Center Management Board and the individuals at the Centers responsible for the FY'78 program planning cycle. The timing of this planning activity has caused us to distribute this document in this unedited form. Thus, it possibly contains errors, hopefully, more of a typographical rather than a technological nature. Nonetheless, the information contained is of a high professional level, reflecting the efforts of the workshop participants and will be invaluable to the planning and successful execution of the Agency's near- and far-term advanced technology program.

Stanley R. Sadin
OAST Space Theme Workshop
Chairman
NASA Headquarters
Study, Analysis, & Planning Office
Office of Aeronautics and
Space Technology

OAST SPACE THEME WORKSHOP
M-2 STRUCTURES AND DYNAMICS WORKING GROUP

SUMMARY COMMENTS ON THEME IMPACT

Two major thrust were identified for structures technology:

1) Large Space Structures

2) Advanced Transportation Structures

A technology program on large space structures was defined to respond to common need perceived for five of the six themes. Greatly expanded power, facilities, and communications/sensing requirements appear to demand a new structures technology for construction in space. Requirements to construct huge structural arrays with precision surfaces in space will need creative research efforts to identify a practical structural elements and construction techniques.

A technology program on advanced transportation structures was defined to respond to the space transportation theme in a timely fashion. Because of the criticality of thermal structures to achieve lower cost transportation systems, renewed emphasis on technology in this area is recommended. The working group was concerned that critical skills and facilities of the Agency in this area have decreased to a critical point. A second technology needing renewed emphasis is the area of recovery and landing technology structures to permit full reuse of launch vehicle propulsion elements.

SUMMARY COMMENTS ON THEME NEEDS AND RECOMMENDED PROGRAMS

Large space structures can be generally grouped into three categories, which define approximately the size, fabrication, and assembly techniques. The first category is structures which are fabricated, assembled, and packaged on earth and automatically deployed in space. Structural technology for this categorgy is the most mature, the maximum size of the deployed structure is dependent on the launch vehicle. The second category is structures which are fabricated and partially assembled on earth with final assembly of the modules/components in space with semi-automated mechanisms. Technology for this category is new with several major areas of unknowns. The third category of structures includes ultra large structures for which economics may dictate that space processing and/or fabrication of major structural components is necessary. Technology for this category is the least advanced and additionally requires interaction on a large scale with astronaut activities.

Mission requirements on structural surface tolerances, structure pointing, etc. will also be a factor in determining which category of structure is used. These accuracy requirements vary from low for solar arrays to very high for earth sensor antennas to ultra high for radio telescopes and SETI antennas.

Modules of manned space stations and orbital transfer propulsion stages of size compatible with launch vehicle cargo bays will be fabricated on the ground and transported to orbit for assembly. Rapid and cost-effective methods of link-up require development of a new qeneration of docking technique, mechanisms, and structures.

Manned Space Stations require the development of 10-20 year lift hibitats for which new technology is required.

The search for Extraterrestrial Intelligence (SETI) brings the most stringent requirement of all the Large Space Structures. The potential requirement for 3 kilometer size antenna of millimeter surface accuracy and RFI shield of similar size present a real challenge for the structure discipline and place the SETI structure into a class of its own.

The use of solar pressure option as a mean of propulsion for the Exploration of the Solar System Spacecraft would necessitate the development of technology for extremely light weight large film structures having requirements different from those of other large space structures. The key parameter for the solar sail is extremely light for kilometer size rather than surface accuracy.

Since the solar sail is only a secondary option as a propulsion system, a low priority was assigned to this type of structures.

To meet the projected needs of the Advanced Space Transportation Theme, the most critical technology area identified related to high temperature structures for earth to orbit reusable launch vehicles. The combined turnaround, and reuse for many hundreds of missions requires specific advancements in structural design concepts to withstand entry heating with substantial weight reductions over the types of structural approaches being used in the shuttle.

Another important area, particularly for Heavy Lift Lanuch Vehicles, is that of landing and recovery. The vertical water or land landing approaches proposed for the very large cargo-type vehicles will require substantial improvements for parachute systems, landing impact loads, and protection of engines from sea water.

In service nondestructive evaluation techniques should provide significant improvements in operational schedules by extending inspection periods for critically loaded structural elements. By developing effective sensing and recording equipment combined with appropriate data readout and processing equipment and software, highly loaded structural elements can be rapidly evaluated after each mission (or series of missions). Teardown for inspection and replacement after an arbitrary fraction of design lift of a pressure vessel or other critical component can be replaced by a retirement for cause criteria based on the permanent NDE system measurement.

Increased support of technology for payload dynamics and acoustics was recommended. The needs identified were to expand efforts to develop methods of reducing severe noise and vibration environments in current vehicles. Additional tasks required are high quality dynamic and acoustic loads data obtained from early shuttle flights and the demonstration of methods to predict the coupled acoustic vibration response of payloads and launch vehicles from a knowledge of each element. Drivers for this technology are cost constraints requiring the elimination of expensive system ground tests and emerging concepts for heavy lift vehicles with large payload masses.

Complex structure configurations combined with varied and rigorous mission profiles result in time-consuming load analysis requirements. The development of advanced computation and data synthesization techniques coupled with appropriate loads analysis computer programs are necessary to realize efficient application of wind tunnel data and information from structural model tests to the determination of design loading conditions. Current space shuttle analysis techniques will be analyzed to identify inefficient steps and the theory and implementing software required to expedite the accurate determination design loads will be integrated into improved computational programs.

The development of damage tolerant design methodology is essential to accommodation of the conflicting demands for minimum structural weight and for high reliability, low maintenance operations. Selection of an adequate degree of damage tolerance in the structural materials can provide significant improvement in the effectiveness of NDE equipment by relaxation of the minimum flow size detection requirements. Development of proof testing criteria and the quantification of the significance of a successful proof test in terms of subsequent assured service life further enhances NDE verified structural reliability. Development of design method which provide a rational means for selection of safety factors and residual strength margins which recognize the damage tolerance capacity of the structure can aid elimination of design overconservation and corresponding improvements in structural efficiency.

NEW INITIATIVES SUMMARY

	TECHNOLOGY NEED	NEW INITIATIVES*
7/M2/1.	Deployable Laser Mirror	———
8/M2/1	Space-Deployed Large Structures	
8/M2/2	Space-Assembled Large Structures	104, 105, 114, 130
8/M2/3	Space-Manufactured Large Structures	
8/M2/4	Orbital Assembly of Modules	———
8/M2/5	Long-Life Habitable Structures	———
9/M2/1	Extremely Accurate Large Antenna	———
9/M2/2	Shield Structure	———
10/M2/1	Solar Sail Structure	R & T Base
12/M2/1	Recovery/Landing Tech. for LVs.	———
12/M2/2	Advanced Vehicle Structures	116
12/M2/3	In-Series NDE Techniques	———
12/M2/4	LV Loads Analysis Optimization	Expand R&T Base
12/M2/5	Payload Dynamics and Acoustics	Expand R&T Base
12/M2/6	Damage Tolerance	Expand R&T Base

* ——— Indicates no new initiative submitted to address this need. Additional new initiative would be required to cover the task described on Form 1.

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED **FORM NO. I**

PAGE 1 OF 2

1. TITLE Deployable Laser Mirror

NO. 7/ M2/ 1
THEME / W.G. / TASK
Other THEMES 8,11

DATE 4 / 28 / 76

2. OBJECTIVE Develop structures technology for deployable mirrors for high power laser transmission.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1990]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [X] MEDIUM [ ] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [ ] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE RR RTOP ? FY78 100k

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY Laser mirror surface materials development.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

a. Stiff deployable support structure and integration of mirror surface with structure for 30-meter laser mirror.

b. Techniques for automatic alignment of mirror surfaces.

c. Define suitability for extrapolating concept to larger sizes.

SPACE TECHNOLOGY NEED

FORM NO. I

TITLE Deployable Laser Mirror

NO. 7/ M2/ 1
THEME / W.G. / TASK

DATE 4 /28 /76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Preliminary design studies, laboratory tests of scaled models, and shuttle flight experiment of model of complete system.

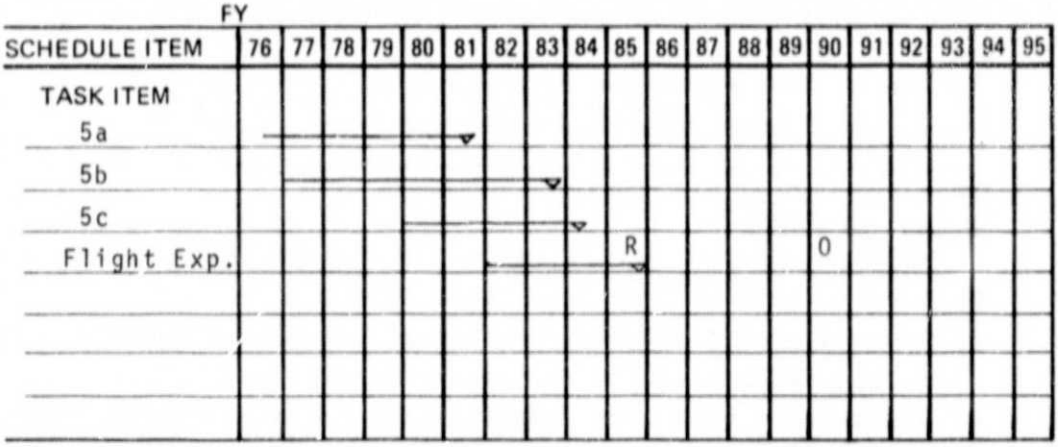
7. ALTERNATIVE APPROACHES/OPTIONS

Microwave transmission antenna.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

RR RTOP ? Preliminary study of system concepts.

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y)																				
INHOUSE	.1	.1	.5	1	1	1.5	2	2	2	2										
CONTRACT																				
FUNDING (10^6 $)																				
INHOUSE																				
CONTRACT	.05	.05	.2	.5	.6	.8	1.5	2.0	2.0	1.0										

SPACE TECHNOLOGY NEED **FORM NO. I**

PAGE 1 OF 2

1. TITLE Space-Deployed Large Structures NO. 08/ M-2/ 01
THEME / W.G. / TASK
OTHER THEMES 7,9,10,11
DATE 4 / 28/ 76

2. OBJECTIVE
Design and develop structural concepts for booms, arrays, reflectors, antennas and platforms using space-deployment of ground assembled components.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [5] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1983-87]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [ ] LOW [X]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR
ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] _____ (Check one or more)

f) R&T BASE CANDIDATE _____

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY
Material development (composites).
Active surface precision control.
Sensing/measuring techniques for accurate alignment.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED
A) Develop computer-aided concept design technicques.
B) Develop thermal stabilized structures.
C) Identify design requirements for all structure types.
D) Develop packaging and deployment mechanisms.
E) Demonstrate technology through Ground/Space testing, sub-scale models, full-scale segments, etc.
F) Define structure/control system interaction.
G) Develop structural accuracy assessment/correction techniques.
H) Develop/verify algorithm for complete structure/dynamics/environment/life representation, etc.

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

TITLE Space-Deployed Large Structures

NO. 08/ M-2/ 01
THEME / W.G. / TASK

DATE 4 /28/76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

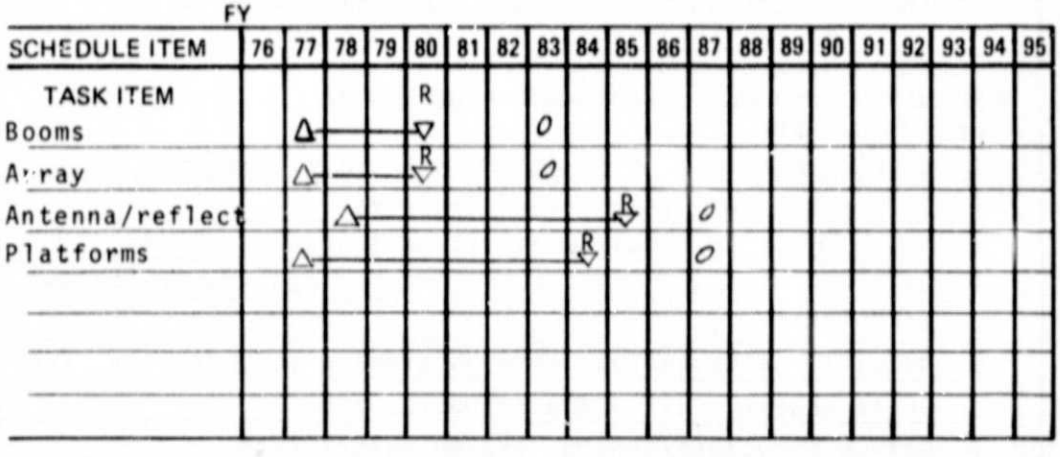
Identify/evaluate/select prime concepts including trade-off studies involving considerations such as packageability, deployment mechanisms/loads, weight, volume, life, configuration precision, etc. Develop analytical representation of selected concepts, design, build models and verify with ground test and flight experiments as required.

7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

506-17-11 Large errectable space structures
506-17-26 Composite Space Structures
750-01-20 Definition of flight experiments

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y) INHOUSE	2	2	10	11	12	12	12	11	10	10										
CONTRACT																				
FUNDING (10^6 $) INHOUSE	0	0	.1	.2	.2	.2	.2	.2	.1	.1										
CONTRACT	.1	.1	.5	1.4	1.9	1.7	1.0	.9	.7	.5										

SPACE TECHNOLOGY NEED FORM NO. 1

PAGE 1 OF 2

1. TITLE Space-Assembled Large Structures NO. 8/ M2/ 2
THEME / W.G. / TASK

DATE 4 /28 /76

2. OBJECTIVE
Design and develop structural concepts for booms, arrays, reflectors/antenna, and space platforms using space assembly of ground fabricated components. (Components can include deployable structures.)

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY DATE: 1983-87

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] _____ (Check one or more)

f) R&T BASE CANDIDATE _____

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY A. Materials development, B. Active Surface Precision Control, C. Manipulators, D. Sensing/Measuring Techniques for acc. alignment.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Develop computer-aided concept design techniques.
B. Develop thermal stabilized structures.
C. Identify design requirements for all structure types.
D. Develop joining, redigization, packaging, and deployment techniques.
E. Demonstrate technology through ground/space testing, sub-scale models, full scale segments, etc.
F. Define structure/control system interaction.
G. Develop structural accuracy assessment/correction techniques.
H. Develop/verify algorithm for complete structure/dynamics/environment/life representation, etc.

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. 1
PAGE 2 OF 2

TITLE Space-Assembled Large Structures

NO. 08/ M-2/ 02
THEME / W.G. / TASK

DATE 4 / 28/ 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Identify/evaluate/select prime concepts including trade-off studies involving considerations such as packageability, deployment mechanisms, loads, weight, volume, life, configuration precision, etc. Develop analytical representation of selected concepts, design, build models and verify with ground test and flight experiments as required, including assembly manipulator-

7. ALTERNATIVE APPROACHES/OPTIONS Many mission requirements can be met with one or more types of structures (shaped antennas vs. phased array). Selected approach will depend on cost, technology readiness, etc.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

506-17-11 - Large Erectable Space Structures

506-17-26 - Composite Space Structures

750-01-20 - Definition of Flight Experiments

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM					R															
Booms	△	—	—	—	▽			O												
Array		△	—	—	B ▽			O												
Antenna/reflect			△	—	—	—	—	—	—	B ▽		O								
Platforms		△	—	—	—	—	—	—	—	B ▽		O								
MANPOWER (M-Y) INHOUSE			10	25	25	30	30	30	25	16										
CONTRACT																				
FUNDING (10^6 $) INHOUSE			.1	.2	.3	.3	.2	.2	.2	.1										
CONTRACT	.2	.2	.6	3.0	3.9	3.6	2.4	1.6	1.8	1.4										

SPACE TECHNOLOGY NEED — **FORM NO. 1**

1. TITLE Space-Manufactured/Assembled Large Structures

NO. 08/ M-2/ 03
THEME / W.G. / TASK
OTHER THEMES: 7,11
DATE 4 / 28 / 76

2. OBJECTIVE
Design and develop structural concepts for booms, arrays, reflectors/antennas and platforms using space assembly of space fabricated/manufactured components.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1987-90]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [X] MEDIUM [ ] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] _____ (Check one or more)

f) R&T BASE CANDIDATE _____

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY Materials development (composites). Active surface precision control. Manipulators. Automated fabrication/manuf. devices. Semiautomated assembly devices. Sensing/measuring techniques for accurate alignment.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A) Develop computer-aided concept design techniques.
B) Develop thermal stabilized structures.
C) Identify design requirements for all structures.
D) Develop fabrication/manufacturing concepts.
E) Demonstrate technology through Ground/Space fabrication and testing of full scale segments and subscale models, etc
F) Define structure/control system interaction.
G) Develop structural accuracy assessment/correction techniques.
H) Develop/verify algorithm for complete structure/dynamics/environment/life representation, etc.

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

TITLE Space-Manufactured/Assembled Large Structures

NO. 08/ M-2/ 03
THEME / W.G. / TASK

DATE 4 /28/76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Identify/evaluate/select prime concepts including trade-off studies involving considerations such as fabrication/manufacturing methods, equipment packaging, assembly mechanisms, weight, volume, life, configuration precision, etc. Develop analytical representation, design, fabrication module. Use module, fabricate, assemble and verify with ground test and flight experiment.

7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

506-17-11 - Large Erectable Space Structures; 506-17-26 - Composite Space Structures; 750-01-20 - Definition of Flight Experiments; 910-31-07 - Large Space Structures/Space Fabrication & Assembly

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM							R					0								
Booms		△	——	——	——	——	▽													
Array		△	——	——	——	——	B ▽					0								
Antenna/reflect			△	——	——	——	——	——	——	B ▽					0					
Platform			△	——	——	——	——	——	——	R ▽					0					

MANPOWER (M-Y) INHOUSE	1	2	5	10	15	15	15	10	5	5										
CONTRACT																				
FUNDING (10^6 $) INHOUSE	0	0	.1	.1	.2	.3	.3	.2	.1	.1										
CONTRACT	0	0	.3	1.0	1.8	2.7	2.3	1.0	.5	.5										

SPACE TECHNOLOGY NEED **FORM NO. 1**

1. TITLE Orbital Assembly of Modules

NO. 08/ M-2/ 04
THEME / W.G. / TASK
OTHER THEMES: 9,12
DATE 4 /28 / 76

2. OBJECTIVE
Develop and Verify Techniques for Manned Space Stations and Orbital Transfer Propulsion Stages

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [4] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY DATE: [1985-90]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [ ] LOW [X]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [ ] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A) Development of Module Positioning and Orientation Manipulation Mechanisms.

B) Development of Automatic Locking and Sealing Module Interfaces (manned modules).

C) Development of Autom. Locking Interfaces Incorporating Propellent Pressurent and Vent Lines; and Electrical Interfaces (orbital Propulsion Stages).

D) Development of Alignment Provisions for Above Interfaces (Accurate Sensing and Positioning).

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. 1
PAGE 2 OF 2

TITLE Orbital Assembly of Modules

NO. 08/ M-2/ 04
THEME / W.G. / TASK

DATE 4 /28 /76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Perform concept studies to select assembly method and design of necessary mechanisms. Develop and test models of critical components. Evaluate performance, life, reliability. Flight tests require early use of Space Shuttle orbiter.

7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

None

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM																				
A		△	—	—	—	R▽				O										
B		△	—	—	—	R▽				O										
C			△	—	—	—	—	—	—	R▽					O					
D			△	—	—	—	—	—	—	R▽					O					
MANPOWER (M-Y) INHOUSE		4	6	6	6	6	4	4	4	4										
CONTRACT																				
FUNDING (10^6 $) INHOUSE																				
CONTRACT		.2	.4	.4	1	1	.1	.1	1	.3										

SPACE TECHNOLOGY NEED FORM NO. 1

PAGE 1 OF 2

1. TITLE Long-Life Habitable Structures NO. 8/ M2/ 5
THEME / W.G. / TASK

DATE 4 / 28 / 76

2. OBJECTIVE Develop Modular Structures for Manned Space Operations with 10-20 Year Life

3. NEED ANALYSIS

a) LEVEL NOW [1], WILL BE LEVEL [1] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [5] FOR OPERATIONAL SYSTEM USE BY [DATE: 1985]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [ ]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY Develop large space structures

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Identify long term degradation hazards and requirements for monitoring and repair.

B. Develop concepts for long term meteroid protection, sealing and leakage control, and thermal fatigue problems.

C. Define methods of accelerated testing.

D. Demonstrate sensing and maintenance techniques by long term/ground tests; perform thermal cycling tests as required.

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

TITLE Long-Life Habitable Structures

NO. 8/ M2/ 5
THEME / W.G. / TASK

DATE 4 /28/ 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Complete Systems Studies to Define Hazards (1978)

Conduct Concept Studies to Minimize/Repair Hazards (1979-80)

Complete Accelerated Long Term Degradation Tests (1982)

Complete Long Term Tests (1988)

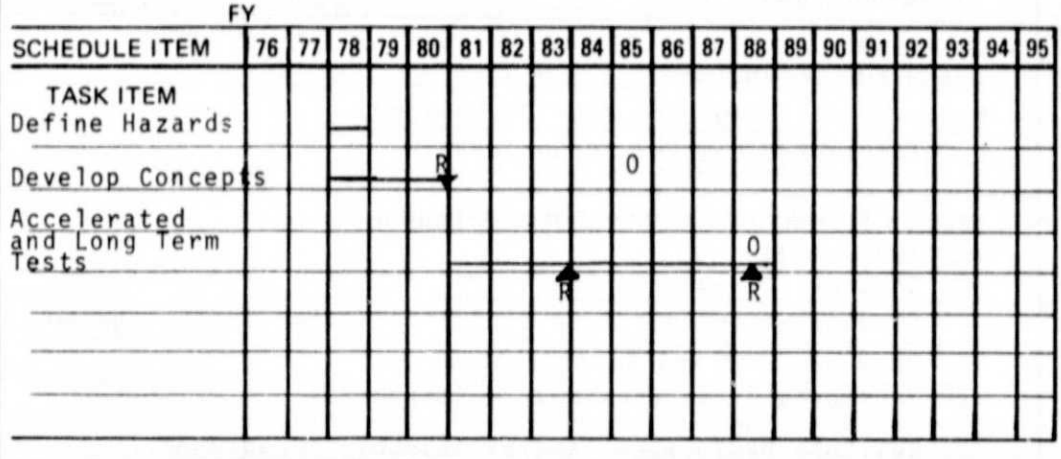
7. ALTERNATIVE APPROACHES/OPTIONS

Accept costs of short-lined structures.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

None

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y)																				
INHOUSE			1	3	3	2	2	1	1	1	1	1	1							
CONTRACT																				
FUNDING (10^6 $)																				
INHOUSE																				
CONTRACT			.2	.3	.3	.3	.3	.2	.1	.1	0	0	0							

SPACE TECHNOLOGY NEED **FORM NO. 1**

1. TITLE Extremely Accurate Large Receiving Antenna Structures

NO. 09/ M2/ 01
THEME / W.G. / TASK
OTHER THEMS: 7,8,11
DATE 4 / 28 / 76

2. OBJECTIVE
Develop technology of spherical reflector for receiving space borne antenna of up to 3000 meter in diameter operating at up to 25 GHZ RF.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [2] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1990]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [X] MEDIUM [ ] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [ ] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY
A. Long Life Composites.
B. Low Cost, Long Life Mesh Technology.
C. Distributed Control Technology.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED
A. Concepts of Antenna Configuration.
B. Structure/Continuous Control Interaction Technology to Produce 1 MM RMS Surface Accuracy
C. Packaging of Antenna and/or Components
D. Reliable Deployment and/or Assembly Technology.
E. Advanced Surface Evaluation Technique in Space.
F. Dynamics of Lightweight, Large Structures.

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. 1

TITLE Extremely Accurate Large Receiving Antenna Structures

NO. 09/ M2/ 1
THEME / W.G. / TASK

DATE 4 /28/ 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Identify concepts for large reflectors.

B. Perform trade-off and select concept.

C. Demonstrate feasibility on a scale model in earth orbit.

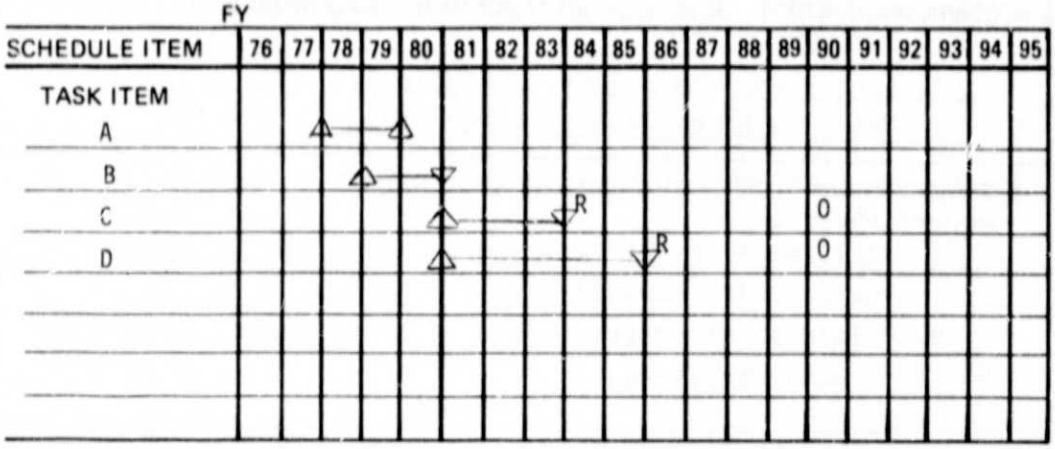
D. Develop surface evaluation technique.

7. ALTERNATIVE APPROACHES/OPTIONS Use arrays of smaller, slaved reflectors.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

One conceptual study at Lockheed Co.

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y) INHOUSE			2	4	4	4	4	4	1	1										
CONTRACT			1	2	2	2	2	2	1	1										
FUNDING (10^6 $) INHOUSE			.1	.2	.2	.2	.2	.2	.3	.3										
CONTRACT			.1	.1	.1	.5	2	4	.5	.5										

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

PAGE 1 OF 2

1. TITLE Shield Structure — NO. 09/ M2/ 02 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

2. OBJECTIVE

Develop technology for a space borne RFI shield, 5000 meter in diameter to be used with extremely accurate large receiving antenna.

3. NEED ANALYSIS

a) LEVEL NOW [7], WILL BE LEVEL [7] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1990]

c) RISK IN ACHIEVING ADVANCEMENT: HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [ ] GRD TEST [ ] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X] OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY

A. Long Life Film and/or Mesh Material.

B. Metallic Deposition on Large Film.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Deployment of extremely large film/mesh structures of low accuracy geometry.

B. Film/mesh structure attitude location with respect to to main structure.

SPACE TECHNOLOGY NEED — **FORM NO. 1**

TITLE Shield Structure

NO. 09/ M2/ 02
THEME / W.G. / TASK

DATE 4 / 28/ 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Identify Concepts for shield configuration and deployment.

B. Select concept after trade-off.

C. Design, fabricate, place in orbit and deploy shield model.

7. ALTERNATIVE APPROACHES/OPTIONS RF band source isolation.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

Solar Sail RTOP (RX----)

FY76 .02

FY77 .

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM A					▲	———	▲													
B						▲	———	▲												
C								▲	———	▲										
MANPOWER (M-Y) INHOUSE					1	1	1	1	1	1										
CONTRACT						1	1	1	1											
FUNDING (10^6 $) INHOUSE					.1	.1	.1	1	.1	.1										
CONTRACT							.1	1	.1	.1		.1	.1	.1	.1					

SPACE TECHNOLOGY N[illegible]D

FORM NO. 1

1. TITLE Solar Sail Structures

NO. 10 M-2 01
THEME / W.G. / TASK
OTHER THEME: 9
DATE 04 /26 /76

2. OBJECTIVE
Develop technology for deployable sail to be used as propulsion system for the exploration of the solar system.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [ ] FOR OPERATIONAL SYSTEM USE BY DATE: [ ]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [X] MEDIUM [ ] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [ ] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE FY 77 (.05M) FY 78 (.05 M)

4 COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY Long life, extremely light, metallized film material

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Sail with a specific weight of the order of 4 grams/M^2
B. Sail size of 500 to 1,000 meters diameter but low surface accuracy
C. Identification of new concepts
D. Mechanisms for deplcyment of light large film structures
E. Packaging of light films
F. Dynamics of film structures and interaction with control

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

TITLE Solar Sail Structures

NO. 10 M-2 01
THEME / W.G. / TASK

DATE 04 / 26 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Evaluate proposed concepts of solar sails and identify new concepts

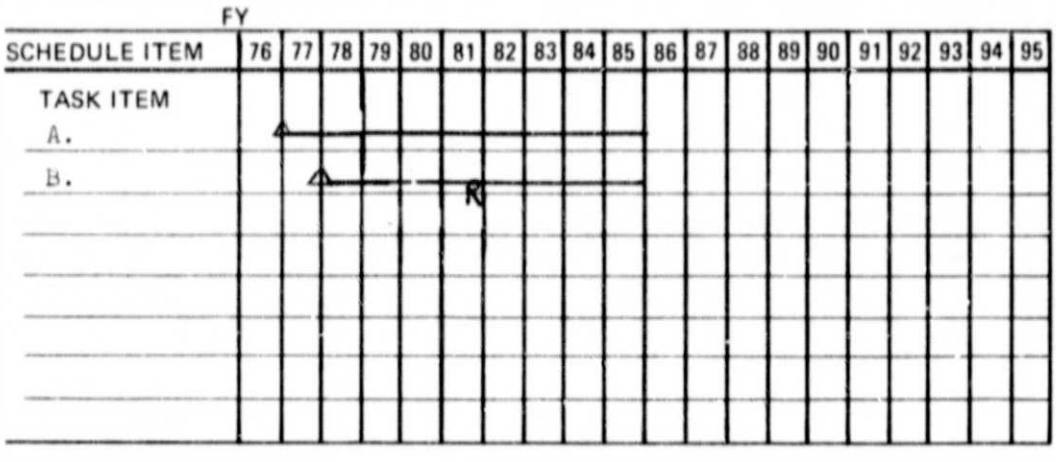
B. Select one concept from trade off

7. ALTERNATIVE APPROACHES/OPTIONS SEP, NEP

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

RX . . . . . RTOP FY 76 .1
FY 77 .1
FY 78 .1

9. TECHNOLOGY SCHEDULES



R&T BASE

MANPOWER (M-Y)
INHOUSE
CONTRACT

FUNDING (10^6 $)
INHOUSE
CONTRACT

SPACE TECHNOLOGY NEED — **FORM NO. I**

1. TITLE Recovery and Landing Technology for Launch Vehicles

NO. 12 M-2 1 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

2. OBJECTIVE

Develop reliable design approaches and analytical methods for water and land recovery, utilizing parachutes, impact attenuation devices, or landing gears.

3. NEED ANALYSIS

a) LEVEL NOW [3], WILL BE LEVEL [5] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [6] FOR OPERATIONAL SYSTEM USE BY DATE: 1985-92

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR
ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [ ] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [X] SPACE FLIGHT TEST [ ]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY None

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Analytical theory for water impact loads on complex structural configurations, verified by testing.

B. Manufacture and flight test of large clustered parachutes.

C. Concepts for reuseable, or low-cost expendable, landing shock attenuation devices for land and water recovery.

D. Very light weight high strength landing gears for single-stage-to-orbit vehicles.

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I**

TITLE Recovery and Landing Technology for Launch Vehicles

NO. 12 M-2 1
THEME / W.G. / TASK

DATE 4 / 28 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Analytical theory will be extended and verified by test for water impact of structural configurations

B. Large, clustered parachutes will be manufactured and flight tested

C. Landing shock attenuation devices will be designed, analyzed, and tested in laboratory

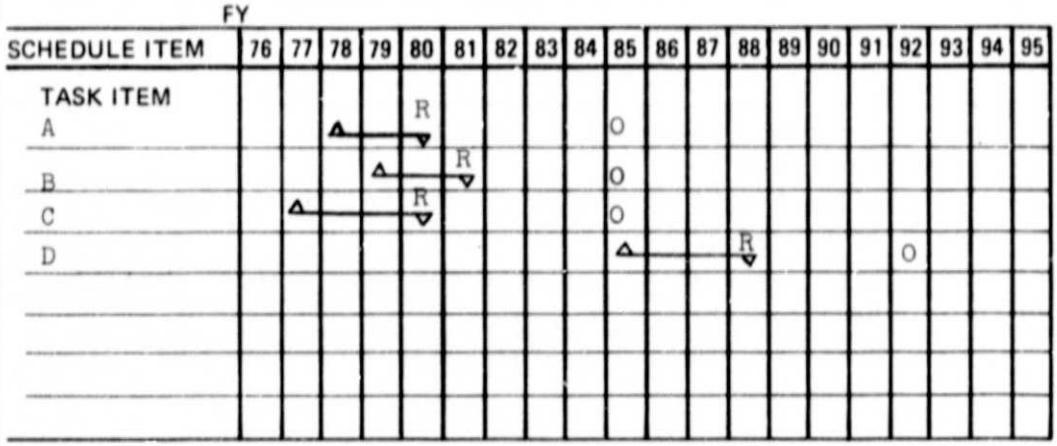
D. Light weight landing gears will be designed, analyzed, and tested

7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

Aircraft and Shuttle Landing Gear Development

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y)																				
INHOUSE																				
CONTRACT																				
FUNDING (10^6 $)																				
INHOUSE																				
CONTRACT			.5	1.0	1.0	.5				.2	.4	.5	.4							

SPACE TECHNOLOGY NEED **FORM NO. 1**

PAGE 1 OF 2

1. TITLE Advanced Vehicle Structures NO. 12/ M2/ 2 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

2. OBJECTIVE
Development of structures which satisfy the weight, life, and temperature requirements of advanced launch and orbital transfer vehicles.

3. NEED ANALYSIS

a) LEVEL NOW [2], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [5] FOR OPERATIONAL SYSTEM USE BY DATE: [1985-95]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [X] OR ENHANCING: HIGH [ ] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [ ]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE 506-17-22 FY78 1000k

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY
A. Composite Materials.
B. NDE Techniques.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED
A. Light Weight Long Life Composite Struct. Assembly Development.
B. High Temperature Reusable Metallic Struct. Assembly Development.
C. Integrated Structure/Tankage/TPS Design Development (Reusable)

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. I

PAGE 2 OF 2

TITLE Advanced Vehicle Structures

NO. 12/ M2/ 2
THEME / W.G. / TASK

DATE 4 /23/ 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Develop, analyze and test, starting with small elements and ending with large assemblies.

Continue development and test of structural components

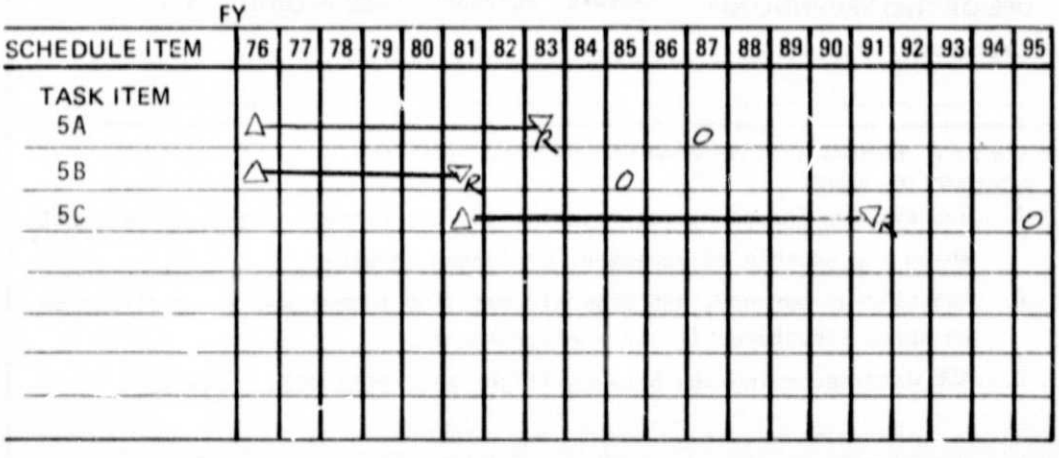
Perform design studies, fabricate and test sub-scale models and full-scale components.

7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

506-17-22 Thermal Structures Concepts for STS

9. TECHNOLOGY SCHEDULES



SPACE TECHNOLOGY NEED — **FORM NO. I**

1. TITLE IN-SERVICE NDE TECHNIQUES — NO. 12/M-2/3 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

2. OBJECTIVE

Develop automated, in-situ durable, NDE instrumentation and recording techniques for SSTO and orbital transfer vehicle structures.

3. NEED ANALYSIS

a) LEVEL NOW [3], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [5] FOR OPERATIONAL SYSTEM USE BY [DATE: 1987]

c) RISK IN ACHIEVING ADVANCEMENT: HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [ ] RESEARCH [ ] GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [ ] OTHER (Specify) [ ] _____ (Check one or more)

f) R&T BASE CANDIDATE _____

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY

Sensors, automated data recording and processing equipment.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. NDE systems for permanent installation on critical structural elements which are capable of repeated, prolonged service.

B. Acoustic holography, and acoustic emission techniques for application to space structures in space environments.

C. NDE data recording and between-flight automatic data analysis.

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED FORM NO. I

TITLE In Service NDE Techniques NO. 12/ M2/ 3
THEME / W.G. / TASK

DATE 4 / 28 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Develop and test acoustic sensors and ultrasonic transmission instrumentation.
B. Develop automatic signal processing and recording equipment.
C. Develop data readout and data processing method.
D. Establish acoustic characterization of typical structural elements.

7. ALTERNATIVE APPROACHES/OPTIONS Extended ground turn around time for disassembly and inspection of critical structures.
In place proof testing.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)
Space flight demonstration proposed on Shuttle Orbiter 102 during development flights.

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM																				
Inst. & Sensor Devl.			—	—	—															
Signal Process. and Record Devel.				—	—	—														
Data Readout & Data Red. Meth.				—	—	—														
Chara. Struct. & Demo. Tech. Readiness						—	—	—	R			O								

MANPOWER (M-Y) INHOUSE																				
CONTRACT																				
FUNDING (10^6 $) INHOUSE																				
CONTRACT			.5	1.0	1.5	2.0	1.5	1.0												

SPACE TECHNOLOGY NEED FORM NO. I

PAGE 1 OF 2

1. **TITLE** LAUNCH VEHICLE STRUCTURAL LOADS ANALYSIS OPTIMIZATION NO. 12/M-2/4 THEME / W.G. / TASK

DATE 4 / 28 / 76

2. **OBJECTIVE**

Improve by an order of magnitude the efficiency and speed of loads analysis methods for large structural systems under launch and flight conditions.

3. **NEED ANALYSIS**

a) LEVEL NOW [2], WILL BE LEVEL [2] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [4] FOR OPERATIONAL SYSTEM USE BY [DATE: 1985]

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [ ] LOW [X]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [ ] MEDIUM [X] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [ ]
GRD TEST [ ] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [ ]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE NEW FY 78 - $100K

4. **COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY** None

5. **SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED**

A. Development of advanced automated computational and data synthesization techniques for the methods and tools of loads analysis of large flexible bodies such as SSTO and HLLV.

B. Development of loads analysis computer programs which automate the processes of wind tunnel data application, structural model development, and selection of significant load conditions for design purposes.

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. I

PAGE 2 OF 2

TITLE LAUNCH VEHICLE STRUCTURAL LOADS ANALYSIS OPTIMIZATION

NO. 12/M-2/4

THEME / W.G. / TASK

DATE 4 / 28 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Analyze techniques presently being utilized by space shuttle. Identify inefficient and time consuming tasks. Develop theory and/or software required to reduce the time required to perform these tasks.

7. ALTERNATIVE APPROACHES/OPTIONS Continue to schedule one-year load cycles.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

Aircraft Loads Automated Design Technology

9. TECHNOLOGY SCHEDULES

SCHEDULE ITEM (FY)	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM																				
A.		Δ	—	—	—	R				0										
B.		Δ	—	—	—	R				0										
MANPOWER (M-Y)																				
INHOUSE		1	1	1	1	1														
CONTRACT		3	3	3	3	3														
FUNDING (10^6 $)																				
INHOUSE																				
CONTRACT		.1	.3	.5	.7	.5														

SPACE TECHNOLOGY NEED — **FORM NO. 1** — PAGE 1 OF 2

1. **TITLE** Payload Dynamics and Acoustics — NO. 12 / M-2 / 5 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

2. **OBJECTIVE**
Methods to determine and reduce dynamic/acoustic response of LV payloads.

3. **NEED ANALYSIS**

a) LEVEL NOW [1], WILL BE LEVEL [3] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [7] FOR OPERATIONAL SYSTEM USE BY [DATE: 1988]

c) RISK IN ACHIEVING ADVANCEMENT: HIGH [ ] MEDIUM [X] LOW [ ]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [X] ANALYSIS [X] RESEARCH [X] GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [X] OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE 506-17-31 FY 78:1M

4. **COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY** Dynamic/acoustic data acquisition systems

5. **SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED**

A. Develop methods to predict acoustic/dynamic response of coupled LV/payload from knowledge of each element

B. Obtain dynamic/acoustic flight data on representative Shuttle payloads

C. Investigate methods of reducing dynamic/acoustic loads e.g. isolation

D. Demonstrate advanced payload response prediction/isolation techniques by flight test

LEVEL OF STATE OF ART

1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED — **FORM NO. I** — PAGE 2 OF 2

TITLE Payload Dynamics and Acoustics — NO. 12 / M-2 / 5 (THEME / W.G. / TASK)

DATE 4 / 28 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

A. Support OAST effort to collect payload dynamics/acoustic flight loads data on early Shuttle flights (Fy 81)

B. Expand base R&T program to develop payload acoustical/mechanical vibration isolation concepts (demonstrate concept on 1985 payload)

C. Apply advanced prediction techniques for coupled response to new payloads, advanced Shuttle configs/heavy lift vehicles (Tech. ready-1985).

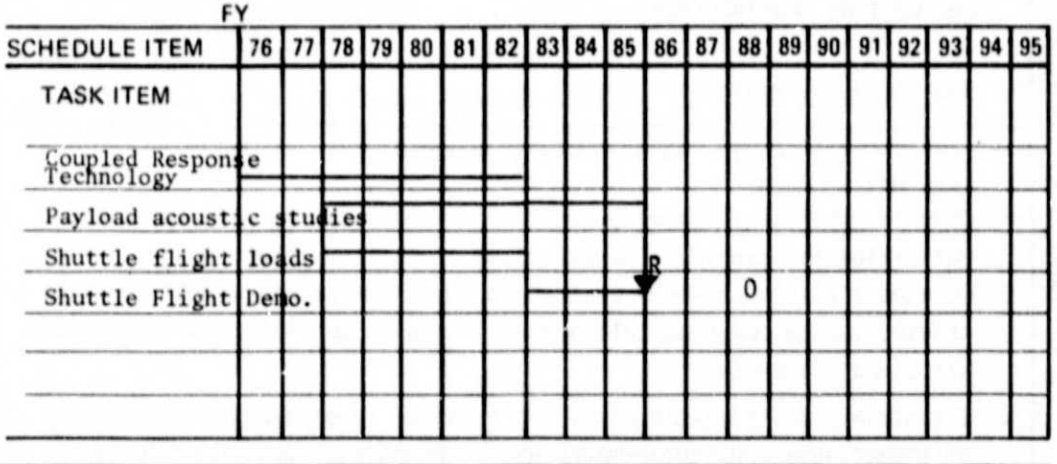
7. ALTERNATIVE APPROACHES/OPTIONS

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

506-17-31

- Will develop fundamental technology for coupled response prediction w/o acoustics

9. TECHNOLOGY SCHEDULES



	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
MANPOWER (M-Y) INHOUSE			4	4	4	4	4	4	4	4										
CONTRACT			3	3	3	3	3	3	3	3										
FUNDING (10^6 $) INHOUSE																				
CONTRACT			.5	.7	.5	.2	.2	.5	.7	.3										

R&D BASE (Net) 1.0 M →

MNPWR (in-house) 40 →

SPACE TECHNOLOGY NEED FORM NO. 1

PAGE 1 OF 2

1. TITLE DAMAGE TOLERANCE FOR LONG LIFE, REUSABLE STRUCTURES

NO. 12 /M2 /6
THEME / W.G. / TASK
OTHER THEMES: 8,9
DATE 4 / 28/ 76

2. OBJECTIVE
Provide design methodology and material flaw initiation and growth data required for design of highly loaded elements requiring minimal service inspection and maintenance

3. NEED ANALYSIS

a) LEVEL NOW [3], WILL BE LEVEL [4] UNDER EXISTING PLANS.

b) REQUIRED ADVANCEMENT – SHOULD BE TECHNOLOGY READY AT LEVEL [5] FOR OPERATIONAL SYSTEM USE BY DATE: 1985

c) RISK IN ACHIEVING ADVANCEMENT:
HIGH [ ] MEDIUM [ ] LOW [X]

d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING [ ] OR ENHANCING: HIGH [X] MEDIUM [ ] LOW [ ]

e) TASKS NEEDED: STUDY [ ] ANALYSIS [X] RESEARCH [X]
GRD TEST [X] AIR CRAFT TEST [ ] SPACE FLIGHT TEST [ ]
OTHER (Specify) [ ] (Check one or more)

f) R&T BASE CANDIDATE $600K FY 78 New

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY
Definition of candidate materials for critical structural elements of launch and OT vehicles.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

A. Develop material toughness, cyclic crack propagation data and failure mode definition for candidate metallic and composite materials.

B. Develop analysis methods required to characterize and quantify mechanical driving forces for flaw enlargement in finite metallic and composite structural elements

C. Establish a design methodology for optimum incorporation of damage tolerance data and requirements with conventional design criteria

D. Demonstrate validity of optimized design methods by test of subscale structural components.

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED
5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

SPACE TECHNOLOGY NEED

FORM NO. 1
PAGE 2 OF 2

TITLE DAMAGE TOLERANCE FOR LONG LIFE, REUSABLE STRUCTURES

NO. 12 /M2/6
THEME / W.G. / TASK

DATE 4 / 29 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

- o Obtain flaw initiation, flaw growth, and fracture characterization of candidate materials
- o Develop inelastic analysis methods for flawed composite and metallic materials
- o Revise conventional design criteria to eliminate over-conservative requirements for tough materials

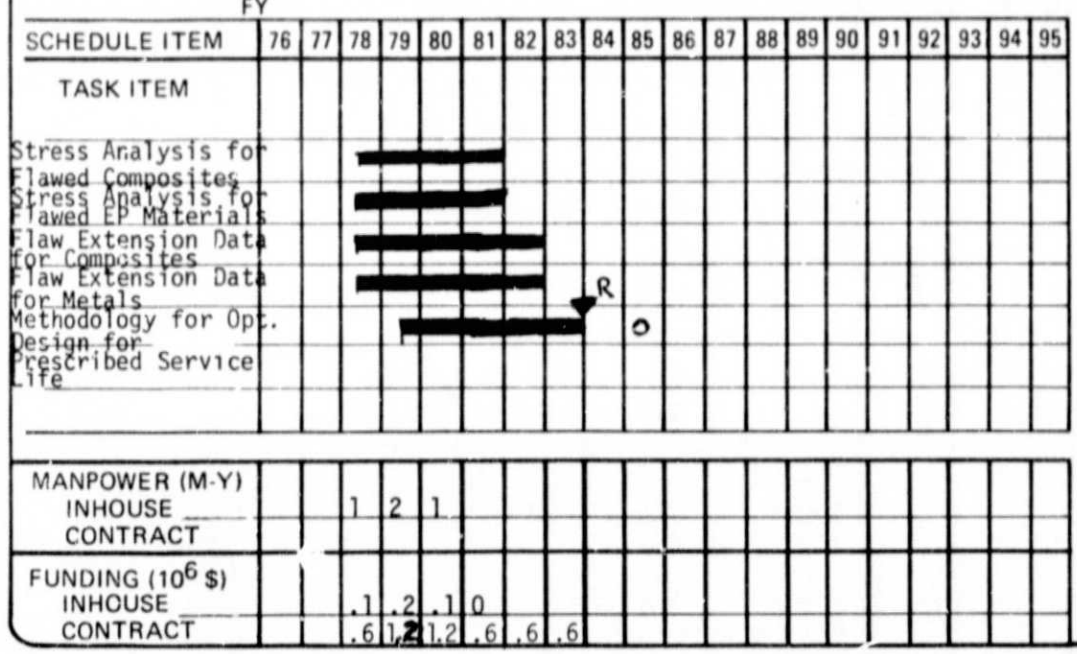
7. ALTERNATIVE APPROACHES/OPTIONS

Flaw sensitive, fracture prone structures providing high risk operations and/or extensive and prolonged maintenance requirements.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

Fracture Control Technology

9. TECHNOLOGY SCHEDULES



SPACE TECHNOLOGY NEED PRIORITY ASSESSMENT

FORM II
FORM III

(List in numerical order, 1 — Highest Priority)

WORKING GROUP M-2

DATE 4 / 28 / 76

TECHNOLOGY NEED NO. / THEME NO.	7 SPACE POWER	8 SPACE INDUST.	9 SETI	10 SOLAR SYS. EXPL.	11 GLOBAL SERVICE	12 ADV. TRANS. SYS.	NASA R&T Current	NASA R&T R&T Base	SUMMARY PRIORITY ASSESSMENT WG	TT	OAST DIV.	
7/M2/1 Deployable Laser Mirror	3	7			5		✓	7	12			
8/M2/1 Space Deployed Large Structures	1	1	2	2	1		✓	1	1			
8/M2/2 Space Assembled Large Structures	2	2	1		2		✓	2	2			
8/M2/3 Space-Mfg. Large Structures	4	5			3				7			
8/M2/4 Orbital Assembly of Modules		4	3			3			5			
8/M2/5 Long-Life Habitable Structures		3							6			
9/M2/1 Extr. Accurate Large Receiving Antenna Struct.	5	8	4		4				14			
9/M2/2 Shield Structure			5						15			
10/M2/1 Solar Sail Structure			6	1			✓	8	13			
12/M2/1 Recov./Lndg Techniques for LV						2			4			
12/M2/2 Advanced Vehicle Structures						1	✓	3	3			
12/M2/3 In-Service NDE Techniques			8			4			8			

SPACE TECHNOLOGY NEED PRIORITY ASSESSMENT

FORM II
FORM III

(List in numerical order, 1 – Highest Priority)

WORKING GROUP M-2

DATE 4 / 28 / 76

TECHNOLOGY NEED NO. / THEME NO.		7 SPACE POWER	8 SPACE INDUST.	9 SETI	10 SOLAR SYS. EXPL.	11 GLOBAL SERVICE	12 ADV. TRANS. SYS.	NASA R&T		SUMMARY PRIORITY ASSESSMENT			
								Current	R&T Base	WG	TT	OAST DIV.	
12/M2/4	Lv Loads Analysis Optimization						6		5	10			
12/M2/5	Payload Dynamics & Acoustics						5	✓	4	9			
12/M2/6	Damage Tolerance		6	7			7		6	11			